Bungee challenge

Activity

Set up and test a model bungee jump, using a piece of elastic. For a given elastic, your task is to predict a launch height that would give the jumper an 'interesting' ride ie stopping a short distance from the ground without actually hitting it.

Background

Figure A29.1 shows the situation. The jumper is launched from rest. When the jumper comes momentarily to rest at the bottom of the first 'bounce', the kinetic energy is again zero. Energy conservation tells us that the gravitational energy lost must be equal to the elastic energy gained by the cord.
A graph of elastic potential energy stored, ΔE_{el}, against extension x (Figure A29.2) can be found from the area under a force–extension graph.

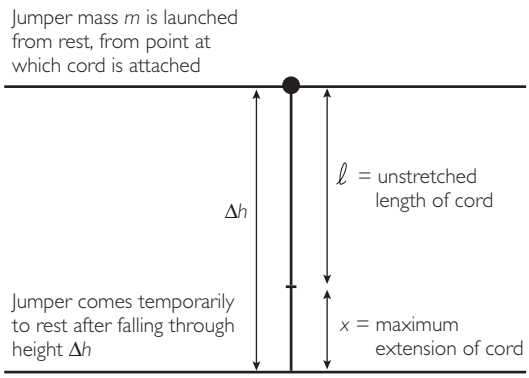

Figure A29.1 A bungee jump

After stretching the cord through an extension x (see Figure A29.1), the gravitational energy lost by the jumper is:

$$\Delta E_g = mg(l + x)$$

ie

$$\Delta E_g = mgx + mgl$$

A graph of ΔE_g against x is therefore a straight line with gradient mg and intercept mgl.

If you plot the graphs of ΔE_{el} and ΔE_g on the same axes, the point where the lines meet shows the extension at which the jumper comes to rest (Figure A29.2).

Maths reference

Linear relationships
See Maths note 5.2
Gradient of a linear graph
See Maths note 5.3

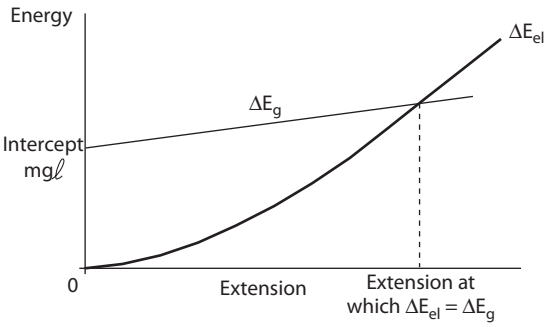

Figure A29.2 Graphs of ΔE_{el} and ΔE_g

Predicting the launch height

To plot the graph of ΔE_g, measure:

- mass of object m =
- unstretched length of cord ℓ=

Work out the intercept of your graph:

- mgl =

Work out the gradient of your graph:

- mg =

Work out the 'rise' of the graph for a 'run' of 1.0 m:

- rise =

Mark the intercept on your graph paper.

Measure a 'run' of 1.0 m and mark the corresponding rise.

Hence draw the straight-line graph of ΔE_g.

Find the extension where the two lines cross:

- x =

Add the unstretched length l to get the total height of the jump:

- $h = l + x$ =

The aim is that the jumper should not quite hit the floor. Add a suitable distance so that the jumper will land within 8 cm of the floor:

- safe-adjusted height =

Evaluation

Perform the bungee jump from your predicted height, with a scrutineer at ground level checking whether you succeed in getting within the 8 cm limit.

Then tick below as applicable.

- I/we predicted the correct height and achieved a drop that was both safe and exciting.
- I/we predicted too high. The jumper survived but complained that s/he had not been scared enough.
- I/we would not be hired as bungee operators.

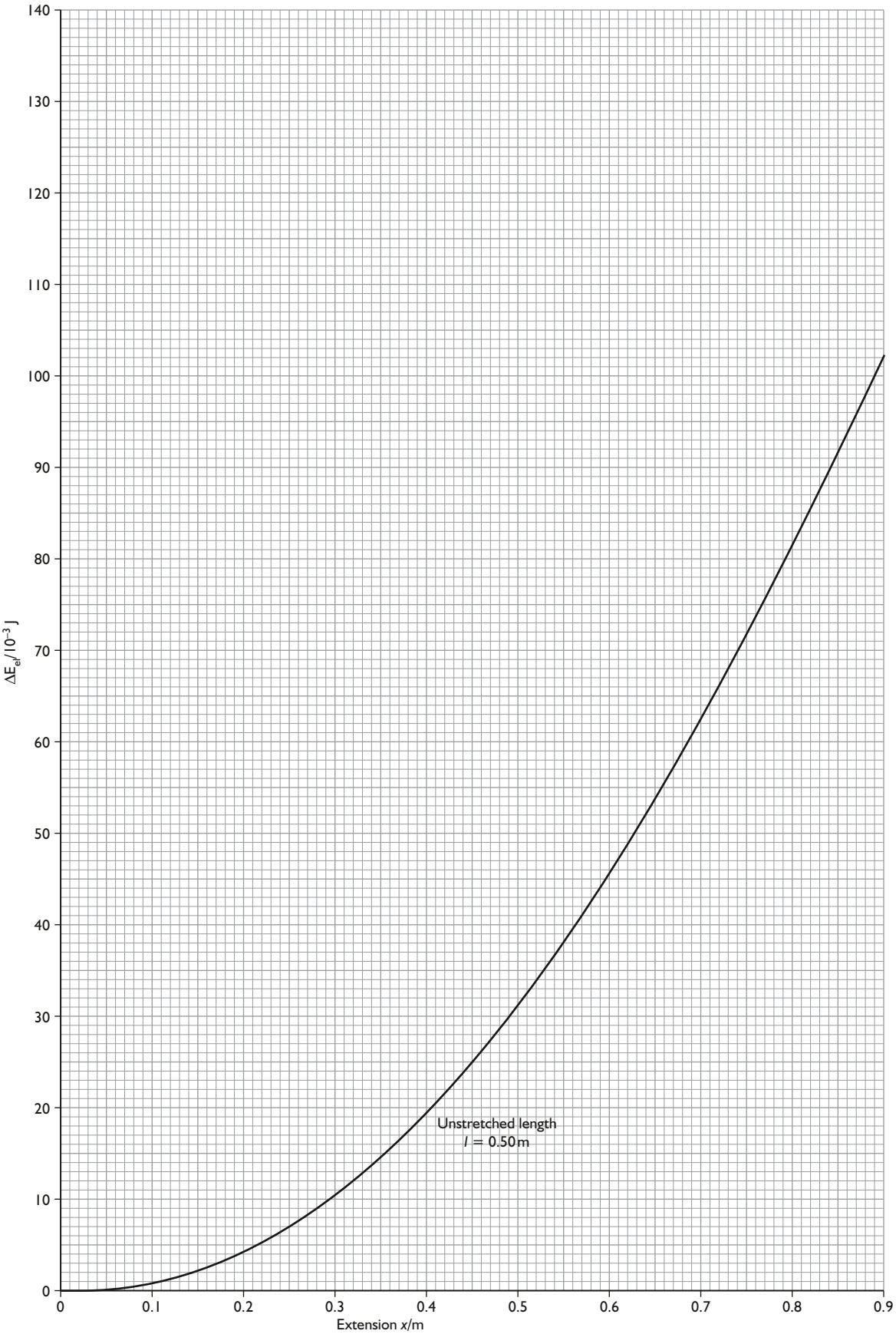

Figure A29.3 A graph of elastic energy stored versus extension for a 50 cm length of Gold Zack knitting elastic